HIGH BRILLIANCE X-RAY SCATTERING FOR LIFE SCIENCES (LIX)

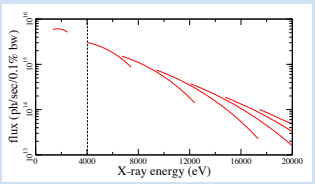
Group Leader: Lin Yang Proposal Team: O. Bilsel[1], B. Hsiao[2], H. Huang[3], T. Irving[4], A. Menzel[5], L. Pollack[6], C. Riekel[7], J. Rubert[8], H. Tsuruta[9], **L. Yang[10]**

[1]University of Massachusetts, [2]Stony Brook University, [3]Rice University, [4]IIT, 5SLS, [6]Cornell University, [7]European Synchrotron Radiation Facility, [8]NEU, [9]Stanford Synchrotron Radiation Lightsource, [10]Brookhaven National Laboratory

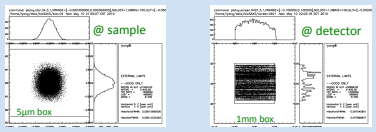
NATIONAL SYNCHROTRON LIGHT SOURCE II ABBIX project • funded by NIH

TECHNIQUES AND CAPABILITIES

- Energy range 2-20keV using undulator source. Simultaneous SAXS/WAXS to cover 0.003-3Å^{-1} at 12keV with 1 micron spot size
- Time-resolved solution scattering with resolution of (1) microseconds to milliseconds using continuous-flow mixing (5μm x 10μm spot size) and (2) milliseconds using stopped-flow mixing or micro-drop mixing (50μm x 20μm spot size)
- Grazing incidence scattering, including anomalous scattering near P K-edge, from membrane structures in multiple bilayers as well as single lipid bilayers that contain membrane proteins (1μm vertical spot size)
- Micro-beam diffraction from biological tissue for imaging and tomography (1μm spot size)

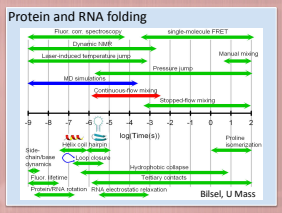


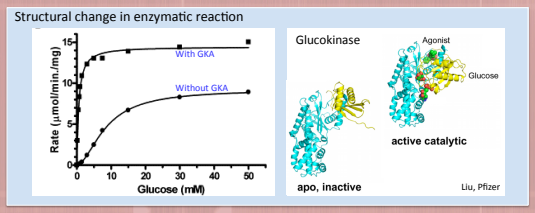
The X-ray flux captured by the primary focusing mirrors. The source is assumed to be a U23 located in a high-b straight section. A secondary focusing pair then further focuses the beam onto the sample as necessary.

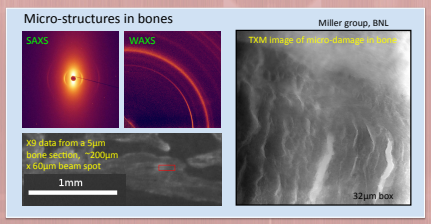


In the most challenging configuration (1 micron beam, low beam divergence to give q_{min}~0.003A^{-1} with a safety factor of ~2.5), ~3% of the flux, or ~10^{13} photons/sec will be available at the sample.

APPLICATIONS

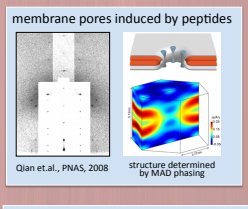


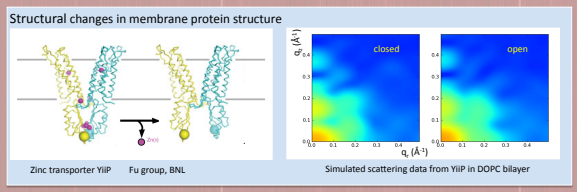


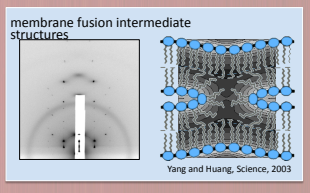


Time-resolved solution scattering with microseconds time resolution is useful for studying protein and RNA folding. With optimized flow cell design, LIX will achieve time resolution of ~10 μs, a factor of 10 improvement compared to the current state of the art. Time resolution of milliseconds will be useful for studying the structural changes in enzymatic reactions. Time-resolved measurements combined with equilibrium measurements provide a more complete picture of how enzymes carry out their functions.

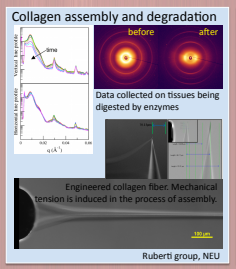
X-ray diffraction using small beams is useful for mapping out structural features in heterogeneous samples. The 1-micron beam size provided by the LIX beamline will enable studies on small structures like micro damage in bones and engineered biomaterials such as collagen-like fibers. Scattering-based tomography also makes it possible to map out the 3-dimensional internal structure of the sample.

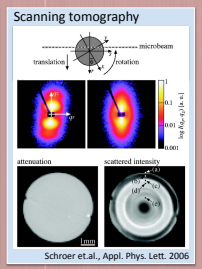






Grazing incident diffraction has already been used to study the structures in multi-bilayers. In addition to extending the energy range for these measurements, the LIX beamline will also provide capabilities to study membrane proteins embedded within a single bilayer, in a solution-like state and under physiological conditions.





ADDITIONAL INFORMATION

The LIX beamline is one of three beamlines in the ABBIX project, which is funded by the National Institutes of Health. It will be highly complementary to the approved ABS beamline, which is optimized for high throughput x-ray scattering measurements of biomolecules in solution.